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ACTIVE INFRARED MOTION DETECTOR FOR HOUSE SECURITY SYSTEM

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ABSTRACT

Nowadays, house security system becomes the best solution to overcome house intrusion problem when user is not in house. As we know, there are many types of house security system which is too expensive and difficult to use. For that reason, an effective house security system at low cost is built where user can also program the security system by their own. This project is focusing on developing a house security system with an active infrared motion detector which is controlled by microcontroller Intel 8051. The overall project is divided into two parts. The first part is concern on the hardware development where all electronics component are connected via the circuit design using wrapping technique. An active infrared, the magnetic sensor, and keypad are the input components while buzzer, indicator, and LCD display are the output components where it's all controlled by controller circuit. The second part is base on software programming to operate the hardware structure. Program for security system based on microcontroller Intel 8051 assembly language is assemble using ASM51 assembler to get the binary file thus, to load into external memory of the hardware structure via serial communication. The process of downloading and executing the program is done using HyperTerminal's communication software to the microcontroller serial port. In order to achieve the best house security system, more detectors or sensors can be connected to the microcontroller output port where it can be reprogram by user using their personal computer at home. As the result, the infrared motion detector is capable to detect motion while the microcontroller is capable to control the whole operation of the security system.

CHAPTER 1

INTRODUCTION

1.1 Background

Motion detection is the action of sensing physical movement in a given area. Motion can be detected by measuring change in speed or vector of an object in the field of view. This can be achieved either by mechanical devices that physically interact with the field or by electronic devices that quantifies and measures changes in the given environment.

There are two device of motion detection which is the mechanical device, and the other one is electronic device. In the mechanical device, a tripwire is a simple form of motion detection. If a moving objects steps into the tripwire's field of view then a simple sound device like bells may alert the user. Mechanical motion detection devices can be simple to implement, but at the same time, it can be defeated easily by interrupting the devices' mechanics like "cutting the wire”.

While in electronic device, the electronic motion sensing such as motion detectors, can prevent such mechanical intervention. The principal methods by which motion can be electronically identified are optical detection and acoustical detection. Infrared light or laser technology may be used for optical detection.

Motion detection devices, such as motion detectors, have sensors that detect movement and send a signal to a sound device that produces an alarm or switch on an image recording device. There are motions detector which employ cameras connected to a computer which stores and manages captured images to be viewed over a computer network.

The applications for such detection are detection of unauthorized entry, detection of cessation of occupancy of an area to extinguish lighting, and detection of a moving object which triggers a camera to record subsequent events. The motion detector is thus a basic idea of electronic security systems.

1.2 Project objective

The objective of this project is to build a house security system using microcontroller Intel 8051 based on active infrared motion detection.

1.3 Project scope

This project concentrates on a development of an active infrared motion detector for house security system. To develop the whole project, it consists of three methods which are the concept of security system, the electrical structure, and the software programming.

The concept of security system is on the detection of movement using active sensor to trigger alarm controlled by the microcontroller Intel 8051. The electrical structure consist of two systems which are the active infrared circuit that used to detect or sense motion and the microcontroller Intel 8051 circuit, used to control the whole operation of the security system. While the software programming is base on

the microcontroller Intel 8051 instruction sets. It contains a program designed for a security system as an interaction to operate the electrical structure.

1.4 Literature review

Motion detectors are mainly used in security systems [4]. It is typically positioned near exterior doorways or windows of a building to monitor the area around it. Since motion detectors are so flexible and have so many uses, it offers feelings of protection and security for the average homeowner as well as commercial organizations [4].

An electronic motion detector is a device used to detect any physical movement in a given area and transforms motion into an electric signal. It consist of sensor that electrically connected to other devices such as security system, lighting, audio alarms, and other applications. Motion sensors are used in a wide variety of applications and as a result, many different types of motion sensors are available including the infrared sensor.

Infrared sensors are widely known in the arts of intrusion detection and in fire or smoke detection. It is a device that often used in automatic light switches and security systems to turn on a light or to activate some other form of alarm or warning indicator when a person enters a monitored area [4]. The infrared sensors have basically two forms: active and passive. [4]

An active infrared detector includes a radiation source and an infrared sensor which is sensitive to interruptions in the radiation sensed from the source. [4] These detectors are used as intrusion detectors by providing a path of radiation from the source to the sensor in a place where the path is likely to be interrupted by an intruder.

The proposed active infrared method of motion detection has the advantage of fast speed response of a relatively large sensor. This advantage permits simpler optical system design, especially for wide fields of view. Besides, it is insensitivity to mechanical and acoustic noise, which presents substantial problems in the passive infrared (PIR) sensors. Low production cost is another advantage of these active infrared detectors. [4]

Passive infrared motion detection detects heat energy radiated or emitted by an object, such as a body of a person, moving across a field of view of a heat sensor of the motion detection system. It is generally use an optical collection system and multiple sensing elements of alternating polarity to create a detection pattern in the volume of interest.

PIR detectors employ a group of radiation sensors coupled through amplifiers to a logic circuit. The radiation sensors detect changes in ambient infrared radiation. The detection system has an electrical circuit operatively coupled to the heat sensor for producing a detection signal in response to the heat sensor detecting a change of temperature caused by the body heat of a person entering the detection pattern.

PIR motion detectors are perhaps the most frequently used home security device. [4] Passive IR motion detectors are usually designed to provide an indication to an alarm panel in response to detecting IR that is indicative of motion of the object. The alarm panel is responsive to receipt of the breach indication to cause an alarm condition to occur.

The other motion detector used in security system is an ultrasonic motion detector. It is commonly used for automatic door openers and security alarms [4]. It is inexpensive and can operate with narrow beam-widths. The ultrasonic transducers are the sensor that used in ultrasonic motion detector. It can be used to detect motion in an area where there are not supposed to be any moving objects. This type of motion detector is most commonly used in burglar alarm systems since they are very effective in this application [4].

In an ultrasonic motion detector, there are two transducers; one emits an ultrasonic wave and the other picks up reflections from the different objects in the area. The reflected waves arrive at the receiver in constant phase if none of the objects in the area are moving. If something moves, the received signal is shifted in phase. A phase comparator detects the shifted phase and sends a triggering pulse to the alarm.

Ultrasonic motion detectors have certain advantages and disadvantages when compared with other types of motion detectors. The main advantage is that they are very sensitive and extremely fast acting. However, the largest problem with this type of motion detector is that it sometimes responds to normal environmental vibration that can be caused by a passing car or a plane overhead. Besides, the installation options on this type of motion detector are limited because ultrasonic beams are easily blocked by thin materials, including paper. False triggering is easily caused by reflections from blowing curtains, pets, and flying insects.

While the passive infrared motion detectors offers problem where it can be falsely triggered by warm air movement or other disturbances that can alter the infrared radiation levels in an area. In order to prevent this problem, newer systems use two infrared sensors, which monitor different zones within a protected area. Logic within system triggers the alarm only when the two zones are activated in sequence, as would occur if a person walked through the protected area.

For that reason, the purpose of using the active infrared as a sensor to detect motion for this project is surely on the advantage offers by the sensor. Its capability on detecting motion with a simple design at lowest cost is needed to build an effective house security system based on motion detection.

1.5 Thesis outline

Chapter 1 explains the background of motion detection, the project objective, the project scope, and the literature review of motion detector for security system. The concepts of motion detector are the major element as a guide for the development of the security system.

Chapter 2 explains the systems involved for the development of the active infrared motion detector for house security system. The understanding of three systems which are the active infrared, motion detector, and house security system stated in this chapter needed for the development of the whole project.

Chapter 3 focuses on the methodologies for the development of the electrical structure and the implementations of microcontroller programming. It gives a brief review on the concept of active infrared motion detector, the electrical structure for hardware development, and the programming for the operation of the security system.

Chapter 4 discusses on the results obtained of the whole project. All discussions are concentrating on the result and performance of the security system. The discussion is valuable for future development of the security system.

Chapter 5 discusses about the conclusion on development of the active infrared motion detector for house security system. The recommendations and modification required on this project is stated in this chapter for further development.

CHAPTER 2

ACTIVE INFRARED MOTION DETECTOR FOR HOUSE SECURITY SYSTEM

2.1 Introduction

There are two systems on a development of the active infrared motion detector for house security system. The first system is an active infrared motion detector and the other one is the controller system. The first system concentrates on a development of an active infrared motion detector. It is consists of three element, which are the active infrared, the motion detector, and the house security system. The motion detector circuit will be control by the second system which is the microcontroller Intel 8051 based system. The combination between this two systems will built a project called an active infrared motion detector for house security system.

2.2 Active infrared (IR)

Infrared is an electromagnetic spectrum at a wavelength that is longer than visible light. It cannot be seen but it can be detected. Objects that generate heat also generate infrared radiation and those objects include animals and the human body whose radiation is strongest at a wavelength of 9.4μ meter. Infrared in this range will not pass through many types of material that pass visible light such as ordinary

window glass and plastic. However it can pass through, with some attenuation, material that is opaque to visible light such as germanium and silicon.

The active infrared sensors use invisible light to scan a defined area. In active infrared systems, there are two-piece elements which are consisting of an infrared transmitter and an infrared receiver. There is a 3/8 inch infrared beam between the transmitter which is placed on one side of the trail and the receiver which is placed on the other side of the trail. The transmitter and the receiver can be separated by as much as 150 feet.

The transmitter emits a beam of light into the scan zone. The light, which is reflected by the background returns to the receiver, which constantly monitors the scan zone. When a person or object enters the zone the infrared light is interrupted. It then sends a signal to the controller system, which is wired into the door controls. One variation of this operating mode is called ‘background suppression’. This is when the receiver only detects a change in the reflected light when a person or object enters the scan zone thus causing a reflectance variation of the light, sending a signal to the microcontroller thus trigger the alarm of the security system.

2.3 Motion detector

A motion detector is a device that contains a motion sensor and is either integrated with or connected to other devices that alert the user of the pre-sense of motion. An electronic motion detector contains a motion sensor that transforms the detection of motion into an electric signal. The electric signal can be connected to a burglar alarm system which is used to alert the home owner or security service after it detects motion.

An example of sensor that used in security system is an active sensor. Active sensors in motion detectors system are commonly used inside homes for a security system. An active motion detector emits optics or sound waves and measures

feedback to detect motion. The simplest type of active motion detector is commonly used in commercial doorways to trigger a doorbell.

A device is fixed to one side of the doorway, an optical sensor to the other. A beam of light will passes from the device through the sensor. When someone enters the establishment, the beam is broken, triggering the doorbell thus warn user for the intrusion. For that reason, active motion detectors can be purchased for home improvement security system. It is inexpensive devices that can add for more security to a home and provide peace of mind for home owners.

2.4 House security system

House security system is one of security that truly related to burglar or safety alarm system. Burglar and safety alarms are found in electronic form nowadays. Sensors are connected to a control unit via either a low-voltage hardwire which in turn connects to a means for announcing the alarm to elicit response.

In a new construction systems are predominately hardwired for economy while in retrofits wireless systems may be more economical and certainly quicker to install. Some systems are dedicated to one mission; handle fire, intrusion, and safety alarms simultaneously.

In common security system, the lights are triggered by motion gives the impression to user that someone is at home and able to see the burglar. Infrared motion detectors placed in house security system in crucial areas of the house can detect any burglars and alert the home owner or police.

The first security system invented, house alarms were triggered by the release of a pressure button fitted into a door or window frame. This basic alarm was

fundamentally flawed as the entire intruder needed to do to silence the alarm was to close the door or window.

While various systems on the market ranging from inexpensive house security alarms to highly sophisticated systems requiring professional installation. All modern alarms are based on the same foundation, the electric circuit which is completed either when the door is opened or closed depending on the security system designed.

The alarm is triggered when the circuit is altered and will not be silenced until a code is punched into the control panel. The most expensive and complicated alarm systems might also involve a combination of motion sensors and pressure pads to ensure even the most cunning intruder doesn't get his hands on treasures.

2.5 Microcontroller Intel 8051

The microcontroller 8051 is an 8-bit machine. Its memory is organized in bytes and practically all its instruction deal with byte quantities. It uses an Accumulator as the primary register for instruction results. Other operands can be accessed using one of the four different addressing modes available: register implicit, direct, indirect or immediate. Operands reside in one of the five memory spaces of the 8051.

The five memory spaces of the 8051 are the Program Memory, External Data Memory, Internal Data Memory, Special Function Registers and Bit Memory.

The Program Memory space contains all the instructions, immediate data and constant tables and strings. It is principally addressed by the 16-bit Program Counter (PC), but it can also be accessed by a few instructions using the 16-bit Data Pointer (DPTR). The maximum size of the Program Memory space is 64K bytes.

The External Data Memory space contains all the variables, buffers and data structures that can not fit on-chip. It is principally addressed by the 16-bit Data Pointer (DPTR), although the first two general purposes register R0 and R1 of the currently selected register bank can access a 256-byte bank of External Data Memory. The maximum size of the External Data Memory space is 64K bytes. The external data memory can only be accessed using the indirect addressing mode with the DPTR, R0 or R1.

The Internal Data Memory space is functionally the most important data memory space. In it resides up to four banks of general purpose registers, the program stack, 128 bits of the 256-bit memory, and all the variables and data structures that are operated on directly by the program. The maximum size of the Internal Data Memory space is 256-bytes. The register, indirect and direct addressing modes can be used in different parts of the Internal Data Memory space.

The Special Function Register space contains all the on-chip peripheral input and output registers as well as particular registers that need program access. The maximum number of Special Function Registers (SFRs) is 128, though the actual number on an 8051 family member depends on the number and type of peripheral functions integrated on. The SFRs can only be accessed using the direct addressing mode while the upper 128 bytes of the Internal Data Memory can only be accessed using the Indirect addressing mode.

The Bit Memory space is used for storing bit variables and flags. There are specific instructions in the 8051 that operate only in the Bit Memory space. The maximum size of the Bit Memory space is 256-bits. Bits can only be accessed using the bit instructions and the direct addressing mode.

2.6 Summary

The understanding on the elements of the systems involved for this project which are the active infrared, the motion detector, and the house security system is needed before proceed for the design and development process. This is important to ensure the project done according to the main idea of each part discuss in this chapter.

CHAPTER 3

METHODOLOGY

3.1 Introduction

There are several steps to be applied in designing an active infrared motion detector for house security system. The relevant information is gathered through literature review from previous chapter.

Data on motion detection and security system projects has been collected where the theoretical design is studied based on the motion detector for security concept. The understanding on the electrical structure for the hardware development is needed for the design circuit process of the motion detector and the basic security circuit.

The next is the hardware development according to the circuit designed. This process is just only being proceed if each part of the circuit being improved is valid, else, it will be repeated until it is valid as the theoretical. Once the hardware development circuits have the output as the expected, then, the comparison for both hardware and theoretical analysis will be done.

Next is the step where software structure is developed for the security system to be interface with the hardware development. While the final step of this research is on applying the whole project to the real house entrance like doors and windows.

3.2 The concept of motion detector for security system

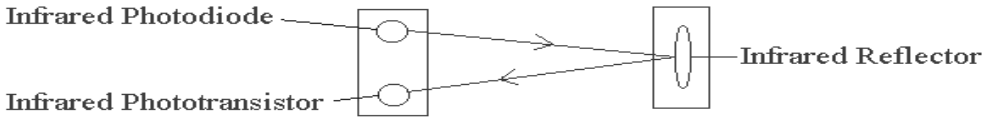

Figure 3.1 Active infrared motion detectors

Figure 3.2 shows the concept of an active infrared motion detector for a security system. In the active system each sensor consists of two housings. The first housing contains an infrared-emitting diode and an infrared-sensitive phototransistor as the infrared detector. The other housing contains an infrared reflector to reflect the infrared signal. When positioned in front of an entrance to a protected area, the two housings establish an invisible beam.

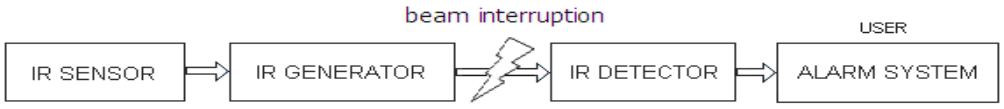

Figure 3.2 The concept of infrared motion detector for security system

A person who enters the area will interrupts the beam causing an alarm to be triggered. For this type of motion detector uses the basic concept of the active infrared motion detector. An interruption in the signal modulated pulsating beam transmit by an infrared diode while receive by an infrared detector will set ‘on’ or ‘off’ the alarm of the security system.

3.3 Hardware development

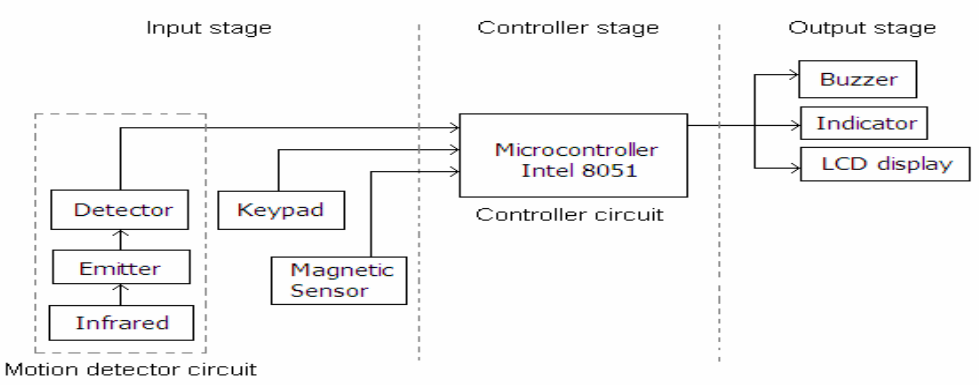

Figure 3.3 Block diagram for the house security system

The hardware development is divided into three stages as shown in block diagram above. The inputs stage of the security system is the motion detector circuit, keypad, and magnetic sensor. The second stage is the controller unit which is the microcontroller Intel 8051. The purpose of using microcontroller is to control the whole system operation by sending data to the output stage which is the LCD display, indicator, and buzzers.

3.3.1 Motion detector circuit

In designing the infrared motion detector circuit, it is based on two basic principle of active infrared motion detector which is the infrared transmitter and infrared receiver as shown in Figure 3.4.

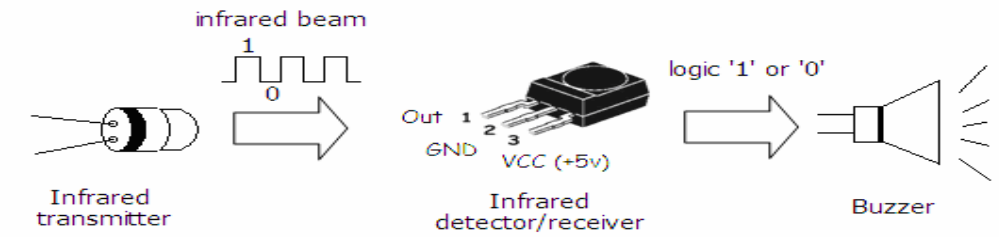

Figure 3.4 Basic principle of infrared operation

3.3.2 Infrared transmitter

For the infrared transmitter which is also known as emitter circuit, it is on a basic design of timer 555 astable operation. The output of timer is connected to the infrared transmitter is used to produce pulse using an astable timer circuit.

In astable circuit operation, pulse will continually generated until the power supplied through the circuit is removed. The astable circuit produces a continuous train of pulses at any frequency required. This means that the 555 timer can operate repeatedly; it will switch ‘on’ and ‘off’ continually to generate data for the infrared transmission.

3.3.3 Infrared receiver

The infrared receiver which is also known as infrared detector receives the data transmitted by the infrared transmitter circuit. It is a simple electronics device on detecting infrared signal.

This infrared detector can be directly connected into the controller circuit to produce logic high ‘1’ or low ‘0’ from the output terminal thus activate or deactivate the controller system operation. The range of infrared detector components according to datasheet stated that the infrared detector can fully operates on detecting the infrared signal of 38 to 45 kHz.

3.3.4 4 × 4 hexadecimal keypad

The purpose of using 4 × 4 hexadecimal keypad in the project is as an input where secure code entries to activate of deactivate the security system operation. The keypad provides eight interface pins, where one pin for each row and column of the keypad matrix. This 4 × 4 hexadecimal keypad is connected to the keypad encoder (MM74C922) to control the keypad bouncing in the hardware development.

3.3.5 Keypad encoder (MM74C922)

The MM74C922 key encoders provide all the necessary logic to fully encode an array of 4 × 4 hexadecimal keypad. It is used to encode the data received from the keypad code entry thus convert into binary code. These binary code is in hexadecimal number is required in data bus of the microcontroller system.

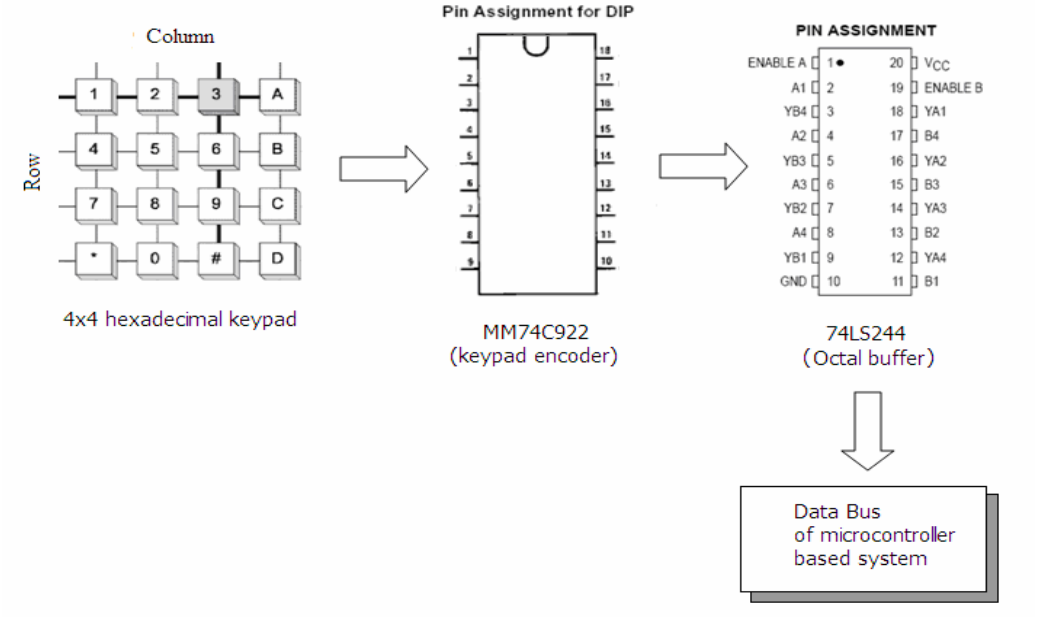

Figure 3.5 Interaction between keypad, keypad encoder, and octal buffer

The figure 3.5 above shows the block diagram on the interaction between the 4 × 4 hexadecimal keypad, keypad encoder (MM74C922), and the octal buffer (74LS244). The keypad is used as a switch to give logic configuration to the keypad encoder.

While the encoder will encode the data configuration from the keypad into the binary code based on datasheet of the encoder. These binary codes will be stabilized using the octal buffer to be process in the microcontroller system. These data will be process by the microcontroller thus running the system operation based on software designed for the security system.

3.3.6 Octal buffer (74LS244)

A buffer is simply a unity-gain amplifier, usually with very high input impedance and very low output impedance. It allows a connection of heavily loaded to another load which requires a lot of current like capacitive load.

The octal buffer is used to isolate one device from another by eliminating loading effects. It provides a ‘buffer’ between the two devices. The 74LS244 are octal buffers and line drivers designed to be employed as the memory address drivers, clock drivers, and bus-oriented transmitters/ receivers which provide improvement on the controller board density.

3.3.7 Microcontroller circuit (Intel 8051 – expended mode)

The controller systems that use to control the motion detector system and other electronic devices are the microcontroller Intel 8051 – expended mode. In expended mode configuration, external ROM and RAM are used to add the data memory to be more than internal memory provided by the Intel manufacturer.

The purpose of using an expended mode for the project is to expend more data available on developing and designing an excellent operation of the security system.

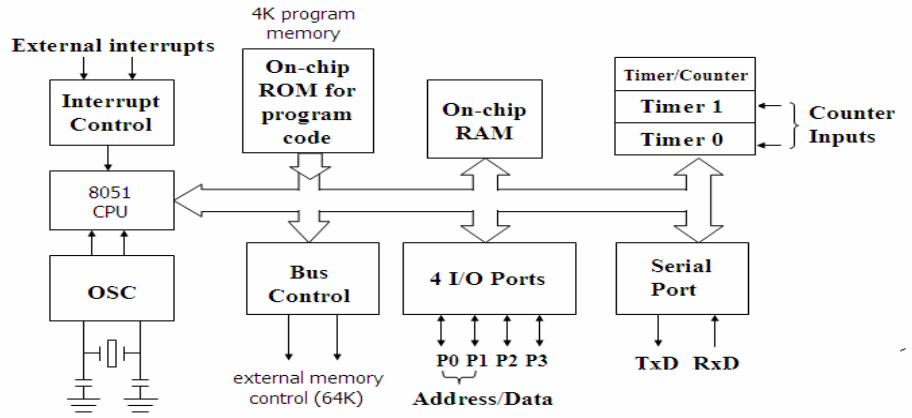

Figure 3.6 Intel 8051 block diagram

The microcontroller Intel 8051 is a widely used on controlling devices and instruments due to its flexibility, existence of multiple producers. It consists of a simple architecture introduced by Intel in the year of 80's. It produced with 128 bytes of RAM, 4K bytes of on-chip ROM, 2 timers, one serial port, and 8-bits wide of ports.

This type of microcontroller become very popular after Intel allowed another manufacturer to make and market any flavor of the 8051, and still remains compatible with 8051. There are various versions of 8051 with different speeds and amount of the on-chip ROM which is valuable on controlling a system designed.

3.4 Software development

The software structure is using the assembly language where a set of program based on security system is assembled using ASM51 assembler. The 8051 Cross Assembler (ASM51) takes an assembly language source file created with a text editor and translates it into a machine language object file. This translation process is done in two passes over the source file.

During the first pass, the Cross Assembler builds a symbol table and labels that used in the source file. While the second pass of the Cross Assembler is actually translates the source file into the machine language object file. During the second pass, the listing file of the assembled is generated for the analysis purpose.

A security program as shown in flow chart below were written in notepad based on 8051 instruction set before assembling process to get the binary code. This binary code is then used to be load into the location of the memory thus operates the hardware developed.

The flowchart as shown in Figure 3.7 is a basic designed for the security system operation. In this security system, the security code is set as ‘1985’ to activate or deactivate security system. When user closed the door, the system will activate where the magnetic switch and infrared is in active condition.

To deactivate the system where opening door without alarm, user must enter the deactivation code. The chance to deactivate the system is once before keypad locked, where user can not enter the code anymore. If deactivation code was correct, green LED will ‘on’ while alarm will ‘off’ condition. System at this time is successfully deactivated and user can open the door without alarm.

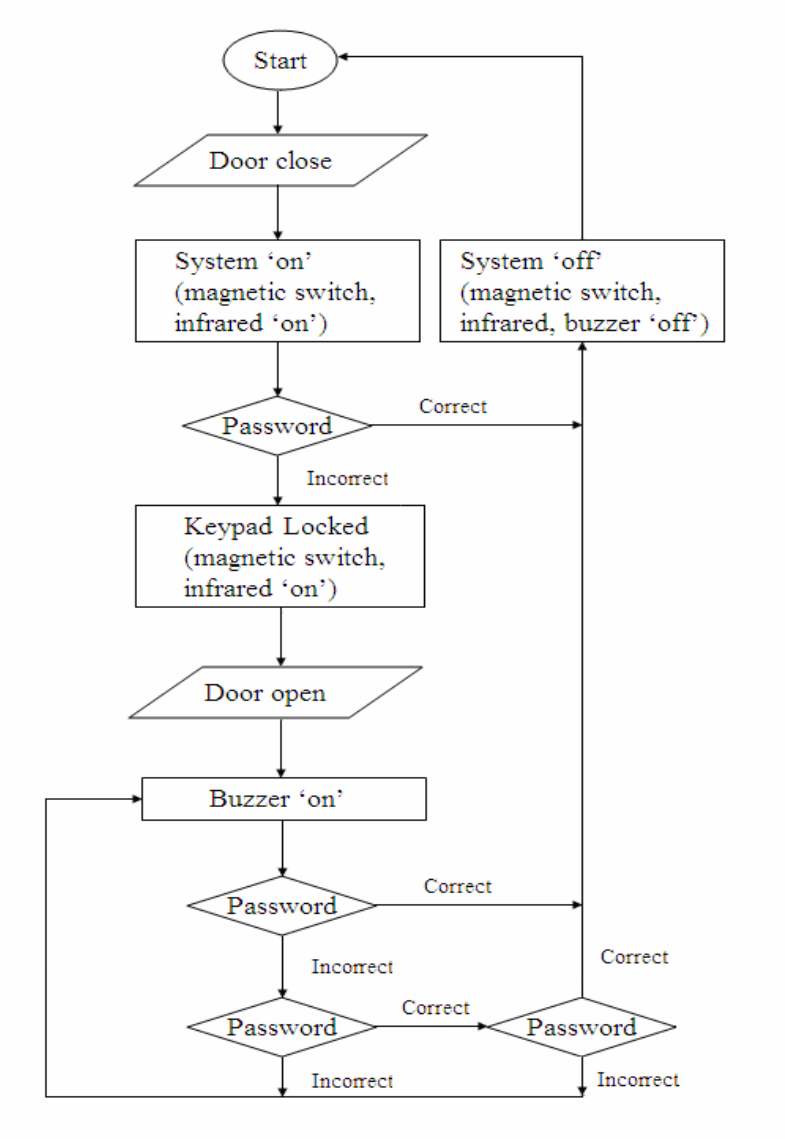

Figure 3.7 Flow chart of software design for the security system

If deactivation code enters was incorrect, system is still activate and for that, red LED and alarm will 'on' where the system is in a warning mode. The system will keep in this mode until the correct deactivation code entered.

When the correct deactivation codes enter, the reconfirm code is needed where user need to reenter the correct deactivation code before the system successfully deactivate; the green LED will 'on' and the alarm will 'off' condition.

The reconfirm code is designed in the system to make more security for the system developed. If intruder open the magnetic switch without entered the correct security code, thus the alarm will ‘on’. User must enter the correct deactivation code to turn ‘off’ the alarm system. The activation and deactivate code for this system are ‘1985’ and the ‘enter’ button codes are ‘A’ for every codes entered.

3.5 Summary

There are three elements discussed in this chapter which are the concept of motion detector for security system, the hardware development, and the software designed for the security system. Each part of these elements is related to each other. The understanding of the concepts and methods on developing the project is very important to achieve the main objective for the whole project.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter will briefly discuss on the results and discussions of the hardware development. There are three major modules in developing the hardware structure which are the active infrared motion detector circuit, keypad module circuit, and the most important; the controller circuit

4.2 Motion detector circuit

The hardware development of the active infrared motion detector system is divided into two parts, which are the infrared emitter circuit and the infrared detector component.

4.2.1 The emitter

The emitter which also known as infrared transmitter circuit was build as shown in Figure 4.1. A probe or the oscilloscope is attached to the infrared LED

while the adjustable resistor is varied to calibrate the emitter to transmit 38 kHz square wave. The Figure 4.1 shows the final configuration of the emitter circuit:

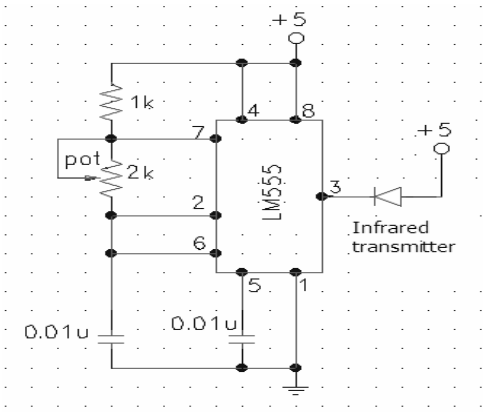

Figure 4.1 The emitter circuit

Figure 4.2 shows the result obtained from the oscilloscope where the frequency generated by the emitter circuit is 38.67 kHz square wave. At this generated frequency, the voltage maximum produced is 1.60V and the peak to peak voltage is 1.16V.

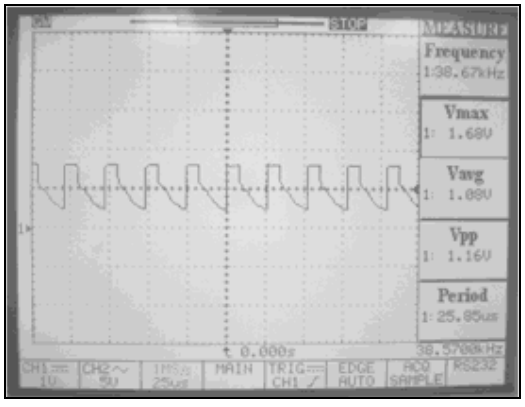

Figure 4.2 The 38 kHz frequency generated by the emitter circuit